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ASSESSMENT OF DISEASE RATES AMONG SEWER WORKERS IN COPENHAGEN, DENMARK

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by

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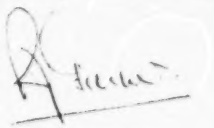
FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The primary mission of the Health Effects Research Laboratory in Cincinnati (HERL) is to provide a sound health effects data base in support of the regulatory activities of the EPA. To this end, HERL conducts a research program to identify, characterize, and quantitate harmful effects of pollutants that may result from exposure to chemical, physical, or biological agents found in the environment. In addition to valuable health information generated by these activities, new research techniques and methods are being developed that contribute to a better understanding of human biochemical and physiological functions, and how these functions are altered by low-level insults.

This report provides an assessment and discussion of the health of sewer maintenance workers in Copenhagen, Denmark, and mortality statistics of such workers. With a better understanding of the health effects, measures can be developed to reduce exposure to potentially harmful materials.



R. J. Garner
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ABSTRACT

Sewer workers in Copenhagen, Denmark have a higher death rate than the comparable male population. An alarmingly high proportion of the deaths occur within the year that employment terminates. Attempts to correlate the statistics with sick leave records or chemicals in the environment have so far not been successful. Sewer workers experience a high rate of gastro-intestinal tract disorders which they associate with chemical odors and infectious agents. They have elevated levels of gamma globulins. Analytical work has not yet identified any agents that might be responsible for the observed death rates or the gastro-intestinal problems. Biological examinations of stool specimens have not been made.

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SECTION 1

INTRODUCTION

The health and working conditions of sewer workers in Copenhagen have been investigated and reported in a series of documents published and discussed over the period 1975-1977. In April 1974 the union representing the sewer workers requested the University of Copenhagen to investigate environmental and health problems of Copenhagen's sewer workers. The study was assigned to J. Mørkholdt Andersen and Tage Egsmose MD, Associate Professors at the University's Institute of Hygiene. Some financial assistance was provided by the municipality from the sewer department's budget.

The preliminary report came out in December 1975 (1), and was published with minor corrections in April 1976 (2). Additional death statistics were presented later (4), and sick leave data were provided by the Municipality (3) as a response to the original preliminary report. In April 1977 a second report was published based on medical consultations with sewer workers (5), and a preliminary report of blood and urine chemistry was issued about the same time (6). Personal communications (7, 8) have greatly helped to interpret the foregoing reports.

In addition to the documents already referred to there have been many news media articles and discussions over the past twenty years concerning the health of sewer workers. This report will attempt to extract the hard data as it applies to the health of sewer workers. Conclusions based on questionnaires will not be considered in detail.

The municipality of Copenhagen serves 600,000 permanent residents, approximately 200,000 transients and commuters and has an industrial load equivalent, on a BOD_5 basis, to 1,600,000 additional persons for a total equivalent load of 2.4 million. The sewage is strong, of the order of 750 mg/l BOD. At the present time sewage is screened to remove rags and large objects and discharged through two outfalls directly to the waters between Copenhagen and Sweden. A modern treatment plant using high rate activated sludge with the UNOX pure oxygen process is under construction and is expected to be in operation in 1979 (4). One small plant uses primary treatment and digestion (8). Over the entire period covered by the reports sewer work involved primarily cleaning and maintenance of sewers, manholes, screens and pump stations. It did not include sewer construction or mechanical shop work such as repairing motors and pumps. About eighty permanently employed workers were classified as sewer workers in 1976. Management of the sewers is a division of the City Engineers office. The sewer workers are members of the Earth and Concrete Workers Union and the Highway Department Workers Club.

"The Sewer Workers Report" (2) is based on four separate studies:

1. Responses to a questionnaire to sewer workers about health and working conditions.

2. A study of sick leave records from January 1957 through December 1973 for sewer workers and a control group of all city office workers.

3. A study of death records compared with national mortality statistics (4).

4. Assessment of reports of analyses of sewer atmospheres for toxic substances.

The report "Sewer Work and Health" (5) is based on clinical consultations with 82 out of 97 sewer workers in 1976. The same group and two control groups were subjected to a battery of tests on blood and urine (6). The reports are considered together.

SECTION 2

CONCLUSIONS

Mortality statistics show that sewer workers die earlier than Copenhagen males of comparable age, many of them soon after termination of their employment. The sewer workers complain of nauseating odors and a high incidence of gastro-intestinal tract disorders. They have elevated levels of gamma globulin but no other significant differences from control groups. The available evidence is insufficient to assign a specific cause for their poor health and reduced life expectancy. It seems probable that biological and chemical insults, caused in part by lax observance and poor enforcement of safety regulations and discharge restrictions have all contributed to the adverse survival expectancy of this group.

SECTION 3

ANALYSIS OF REPORTS

QUESTIONNAIRES AND SICK LEAVE RECORDS

Responses to the questionnaires as well as the medical consultations clearly show that sewer workers consider their job to be unhealthy and unsafe. A detailed analysis of the responses to the questionnaires is not included because the responses are difficult to reproduce and are liable to be influenced by local customs and recent news items concerning the environment. Sick leave records are also difficult to analyze because the decision to take sick leave is made by the worker and not on the basis of a medical examination. In Denmark sick leave pay for permanently employed Municipal workers is 100 percent of base pay but does not include extra pay for "dirty work". Medical confirmation of short illness is seldom required.

Table 1 compares sick leave for permanently employed sewer workers over the period 1959-1973 with male office workers of comparable ages in the year 1964. At all ages above 30 years the sewer workers take more leave than office workers. Most significant is the high percent of sick leave taken by sewer workers over 50 years of age. Workers over 60 years of age take an average of one day in five sick leave.

The rebuttal from the City Engineers Office (3) gives the comparative sick leave data shown below, unfortunately without age adjustment.

Sick leave rates of unskilled wage earners in the City Engineers Office, not adjusted for age (3).

	1973	1974
Parking meter collectors	6.12%	6.48%
Street cleaners	7.07%	7.31%
Sewer workers	7.63%	8.77%
Street repairmen	8.06%	9.42%
Garden and park workers	10.64%	10.86%
Workshop and Warehousemen	10.30%	12.17%

There are relatively few transfers between work groups (8). The high sick leave of garden and park workers is attributed to hazardous working conditions, as in trees, rather than a selection of older workers for garden and part work. There is no evidence that sewer workers take more sick leave than other manual workers although sewer workers certainly take more sick leave than office workers (2,7).

TABLE 1. COMPARISON OF SICK LEAVE FOR PERMANENTLY EMPLOYED SEWER WORKERS (1959-1973) AND CITY OFFICE WORKERS (1964) (2, 7)

	Sewer Workers			Office Workers		
Age	Sick days	Year days*	%Sick days	Sick days	Year days*	%Sick days
24	6	1032	0.6	345	23736	1.5
25-29	65	9288	0.7	510	35088	1.5
30-34	564	19608	2.9	840	48160	1.7
35-39	1536	33024	4.7	915	62952	1.5
40-44	1954	31992	6.1	1560	89440	1.7
45-49	1408	27520	5.1	3107	82216	3.8
50-54	1382	15480	8.9	3640	96320	3.8
55-59	1044	10664	9.8	4116	101136	4.1
60-64	496	2408	20.6	6880	118336	5.8
65+	127	688	18.5	3072	66048	4.7

*Year days equals number of working days per year times number of employees in age groups, i.e. days worked plus sick days. Three weeks vacation not included.

The second study (5) was recommended by the authors of the first report (2), and was financed by the municipality to investigate health problems among sewer workers. Matched control groups from the city gardeners and from office workers were chosen by the Municipal personnel office and their blood and urine chemistry were determined (6); however not enough money was supplied for a medical examination of the controls. This report confirmed the questionnaires of the first report (2) and concluded that sewer workers have a higher than normal incidence of acute symptoms of gastro-intestinal disorders including nausea, vomiting and diarrhea. It further concluded that the disorders are directly related to the intensity of exposure to sewer odors and splash. Half of the workers have had diarrhea in the past year and 10% say they have experienced it one or more times a week. The frequency of the disorders is related to current exposure and not to years of experience. Few workers go to their doctors for treatment for gastro-intestinal disorders but seem to consider them to be a part of the job. No examinations of stool specimens were made.

The doctors making the 81 examinations found 21 cases of occupational disease which were reported to the Health Service doctor. An additional 25 cases were not reported because the workers did not wish it.

Many workers consider that odors rather than infectious agents cause their gastro-intestinal disorders, e.g, one told the doctor, "suddenly you get this stench in the face and then you know you will have stomach trouble for the next few days" (5).

In a publication from the Occupational Health Office a steward said, "longer vacations are necessary because we have a very special problem getting accustomed (to the sewer environment). After a vacation of a week or more one is almost always sick the first two or three work days with vomiting, nausea, headaches and smarting of the eyes. We don't know what we owe it to but it is most likely the chemicals in the sewer" (10).

ANALYTICAL DATA

The chemical analyses reviewed (2) provide no evidence for toxic chemicals that might be related to acute gastro-intestinal problems. Solvent vapors occasionally exceeded hygienic standards for one hour's exposure and hydrogen sulfide once reached 13 ppm versus a standard of 10 ppm. There is little doubt that industrial discharges frequently contribute high levels of organic vapors to the sewer contrary to regulations. Many of these discharges are of short duration and are therefore difficult to identify. The effect of these vapors on the health of sewer workers is at present only conjecture. One station was found to have three times the allowable level of benzene when a sick worker was replaced (5). There was, however, no diagnosis of benzene toxicity in the sick man, who is now dead (8). One case of high lead in the blood was found in a worker who had been cleaning heating coils in a sludge digester (5, 8). The job was very dusty and the dried sludge had a lead content over 100 mg/kg. The worker was transferred to another job and his blood Pb levels returned to the normal range. Masks are specified for workers in dust or spray but the worker may not have been using his mask effectively. The second study (5) includes photographs of a

worker who was using a high pressure spray to clean screens but was not using a mask, and of a worker who was not using his gloves to handle a wooden ball used to clean the sewer, again contrary to regulations.

In the report of medical consultations with sewer workers (5), the doctors conclude that the working environment is responsible for a high level of acute disorders of the gastro-intestinal tract. They also conclude that sewer workers have a high level of chronic problems including fatigue, difficulty in concentrating, headaches, dizziness as well as psychic problems.

The preliminary report of clinical laboratory analyses (6) showed little essential difference over a wide range of chemical parameters between sewer workers and the control groups chosen by the personnel office. In many cases the sewer workers, as a group, fell between office workers and garden workers. The only significant difference was an elevated level of gamma globulins among sewer workers, suggesting that they have had more infections than the other groups. The biochemical examinations have not yet been completed.

DEATH RATES AMONG SEWER WORKERS

The initial study (1) showed 24 deaths among 142 sewer workers who had been employed for at least one year in the period 1957-1973. This is significantly greater than the death rate for all Copenhagen men of comparable ages. An updated report (4) added 9 additional deaths that had not been supplied to the authors at the time of the original study. Table 2 groups the workers by years of employment and shows the comparable death rates for Copenhagen males based on the 1975 statistical yearbook. Death rates in Copenhagen do not change very much from year to year.

Workers who have spent 1 to 8 years in sewer work in the 15 year study period have a death rate indistinguishable from the city rate. For the next 8 years of employment the rate is more than twice the expected rate. A statistical analysis of the data shows the following: The chi-squared test on the two groups 1-8 years and 9-16 years is highly significant. Individual groups were tested against the Poisson distribution. Death rates for workers with 9-12, 11-12, 15-16+ and 13-16+ years of employment were all significant at the 5% level or better. Therefore one can conclude that workers who have spent more than 8 years in Copenhagen sewers have about twice the death rate of all Copenhagen males. The normal death rate during the first 8 years of employment also reflects an adverse environment since sewer workers are selected from healthy able-bodied males who should have a death rate significantly below the city average (11).

When the causes of death of the original 24 cases were examined (2), the only outstanding difference from the national average was for cancer of the pancreas. Of 9 cases of cancer recorded on the death certificates there were 3 cases of cancer of the pancreas, 2 cases of lung cancer and 1 each of four other cancers. The expected rate of pancreatic cancer was only 0.3 among 24 deaths of men over 25, therefore 3 deaths are highly significant. There were no additional cases of pancreatic cancer among the 9 additional deaths reported (4,7). A recalculation based on an expected 0.414 deaths out

TABLE 2. DEATH STATISTICS FOR SEWER WORKERS (4)*

Years of sewer work	Number of deaths N	Expected deaths E	Chi squared $(N-E)^2/E$	Poisson Cumulative Probability for N or more deaths in %
1-2	1	2.0		
3-4	2	2.3		
5-6	3	2.6		
7-8	2	2.7		
1-8	8	9.6	0.27	
9-10	6	3.0		8.2
11-12	8	2.8		0.75†
9-12	14	5.8		0.25††
13-14	4	2.5		24.
15-16+	7	3.1		3.7†
13-16+	11	5.6		2.6†
9-16+	25	11.4	16.22	
1-16+	33	21.0	16.49††	

*Statistical calculations by R.B. Dean

†Significant at the 5% level

††Significant at the 0.5% level

of 33 shows a Poisson probability of 0.8% for 3 or more deaths. The death certificates are currently being studied for other possible correlations (7).

Over 40% of dead former sewer workers died within the calendar year in which they stopped working (2). The calculation is based on 210 sewer workers of whom 111 left the work force in the years 1959-1973. Thirty-two of these had died by the end of 1976, 13 of them in the year that employment terminated. The ages at death of 12 of the 13 men who died in the year that employment terminated were evenly distributed between 51 and 58 years. Some of these men were ill when they stopped working. Put another way, 12% of the former workers died in the calendar year in which they terminated work. For comparison only 1% of Copenhagen males aged 55 and 3% of those aged 65 will die within the twelve months following their respective birthdays. Comparative data for other occupations in Copenhagen is not available.

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